

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
22 July 2004 (22.07.2004)

PCT

(10) International Publication Number  
**WO 2004/062104 A3**

(51) International Patent Classification<sup>7</sup>: **H03K 4/00**

(74) Agent: ASAHI, Kazuo; Nishi-Shinbashi Noa Building,  
4th floor, 18-9, Nishi-Shinbashi 1-chome, Minato-ku,  
Tokyo 105-0003 (JP).

(21) International Application Number:  
PCT/JP2003/016823

(81) Designated States (*national*): CN, US:

(22) International Filing Date:  
25 December 2003 (25.12.2003)

(84) Designated States (*regional*): European patent (AT, BE,  
BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU,  
IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR).

(25) Filing Language: English

(26) Publication Language: English

Published:  
— with international search report  
— with amended claims and statement

(30) Priority Data:  
2002-382475 27 December 2002 (27.12.2002) JP

(88) Date of publication of the international search report:  
14 October 2004

(71) Applicant (*for all designated States except US*): SEIKO  
EPSON CORPORATION [JP/JP]; 4-1, Nishishinjuku  
2-chome, Shinjuku-ku, Tokyo 163-0811 (JP).

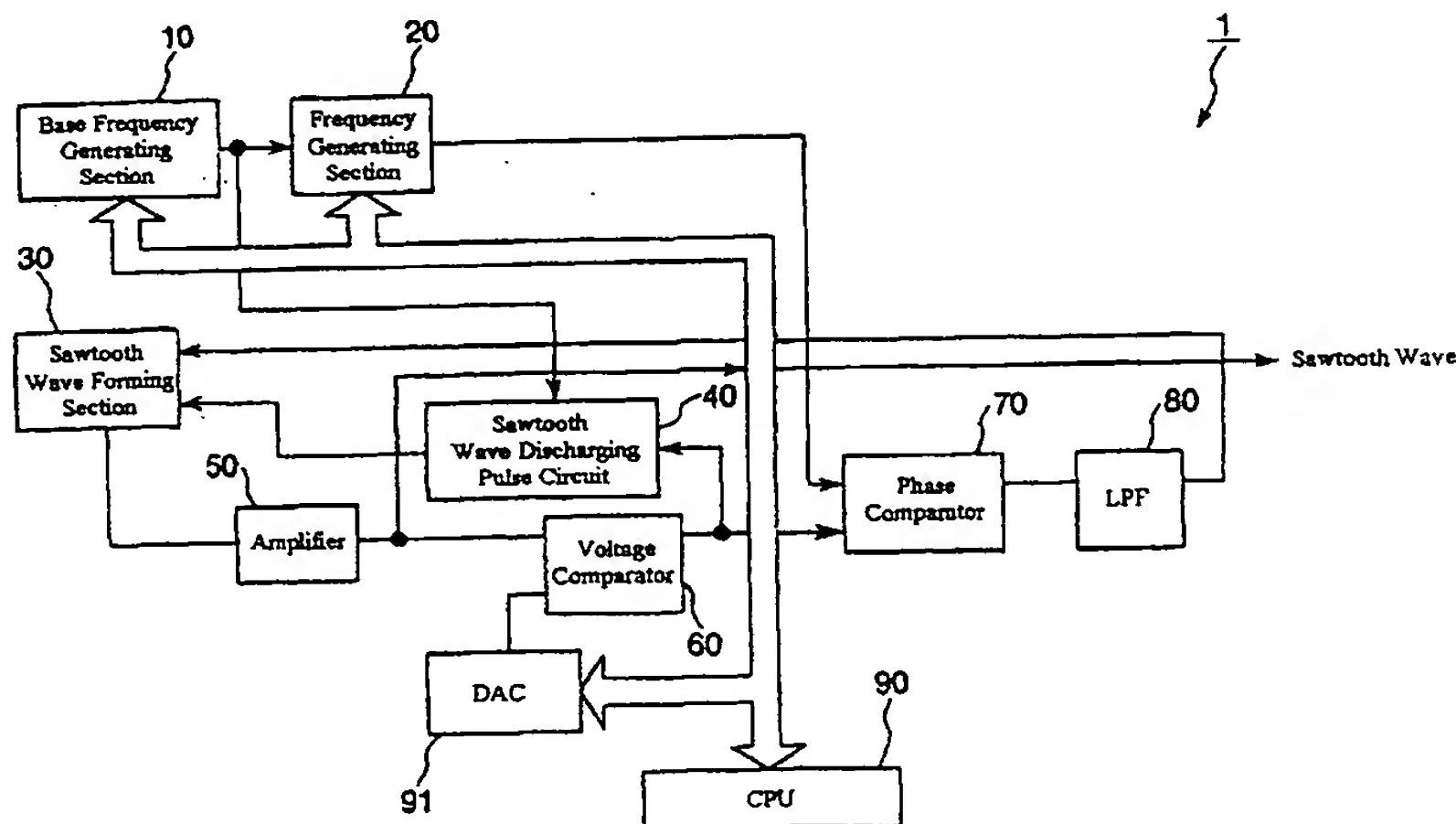
Date of publication of the amended claims and statement:  
6 January 2005

(72) Inventor; and

(75) Inventor/Applicant (*for US only*): TAKEUCHI, Ke-  
satoshi [JP/JP]; c/o SEIKO EPSON CORPORATION, 3-3,  
Owa, 3-chome,, Suwa-shi, Nagano-ken 392-8502 (JP).

For two-letter codes and other abbreviations, refer to the "Guid-  
ance Notes on Codes and Abbreviations" appearing at the begin-  
ning of each regular issue of the PCT Gazette.

(54) Title: A SAWTOOTH WAVE GENERATING APPARATUS, A METHOD OF GENERATING SAWTOOTH WAVE, A CON-  
STANT CURRENT CIRCUIT, AND A METHOD OF ADJUSTING AMOUNT OF CURRENT FROM THE SAME



(57) Abstract: A sawtooth wave generating apparatus 1 includes a base frequency generating section 10 and a frequency generating section 20 for generating the frequency of a reference signal, a sawtooth wave forming section 30 which forms a sawtooth wave based on the reference signal, a voltage comparator 60 which compares the voltage value of the sawtooth wave formed by the sawtooth wave forming section 30 with a predetermined voltage value, a phase comparator 70 which compares the phase of the output signal from the voltage comparator 60 with the phase of the reference signal, and a low-pass filter (LPF) 80 which cuts out a high frequency component of the output signal from the phase comparator 70, and feeds back the resulting output signal to the sawtooth wave forming section 30.

## AMENDED CLAIMS

[received by the International Bureau on 27 September 2004 (27.09.2004);  
original claims 2, 3, 10 and 11 amended; remaining claims unchanged (3 pages)]

1. A sawtooth wave generating apparatus for generating a sawtooth wave, the apparatus comprising:

a reference signal generating section for generating a reference signal having a predetermined frequency;

a sawtooth wave forming section which forms a sawtooth wave based on the predetermined frequency of the reference signal generated by the reference signal generating section; and

a correcting section which automatically corrects a slope of the sawtooth wave defined by  $\Delta V/t$  which is formed by the sawtooth wave forming section in response to variation of the predetermined frequency of the reference signal.

2. (Amended) The apparatus as claimed in claim 1, wherein the reference signal is a square-wave having rising edges and trailing edges, and the correcting section comprises:

a voltage comparator which compares the voltage of the sawtooth wave formed by the sawtooth wave forming section with a predetermined voltage;

a phase comparator which compares the phase of [~~the rising edge of~~] the reference signal generated by the reference signal generating section with the phase of the output signal from the voltage comparator; and

a low-pass filter which cuts out a high frequency component of the output signal from the phase comparator, and feeds back the resulting output signal to the sawtooth wave forming section.

3. (Amended) The apparatus as claimed in claim 2, wherein the phase comparator outputs a low-level signal so as to make the value  $\Delta V/t$  smaller in the case where the phase of the output signal from the voltage comparator is earlier than the phase of [~~the rising edge of~~] the reference signal, and the phase comparator outputs a high-level signal so as to make the value  $\Delta V/t$  larger in the case where the phase of the output signal from the voltage comparator is later than the phase of [~~the rising edge of~~] the reference signal.

10. (Amended) A method of generating a sawtooth wave, the method comprising the steps of:

generating a reference signal having a predetermined frequency, the reference signal being a square-wave having rising edges and trailing edges;

forming a sawtooth wave based on the generated reference signal;

comparing the phase of [~~the rising edge of~~] the reference signal with the phase of [~~the apex of~~] the formed sawtooth wave; and

automatically correcting a slope of the sawtooth wave defined by  $\Delta V/t$  based on the result of the phase comparison.

11. (Amended) The method as claimed in claim 10, wherein the automatically correcting step comprises:

generating a pulse signal when the voltage value of the sawtooth wave reaches a predetermined voltage value;

comparing the phase of the pulse signal with the phase of [~~the rising edge of~~] the reference signal; and

correcting the slope of the sawtooth wave so as to make the value  $\Delta V/t$  smaller in the case where the phase of the pulse signal is earlier than the phase of [~~the rising edge of~~] the reference signal, and to make the value  $\Delta V/t$  larger in the case where the phase of the pulse signal is later than the phase [~~of the rising edge~~] of the reference signal.

12. A constant current circuit which outputs a constant current, a current control device which resides outside of the constant current circuit being capable of controlling the amount of the output current of the constant current circuit, the circuit comprising:

a constant voltage source capable of outputting a constant voltage;

a second FET, a gate electrode of the second FET being connected to the output side of the constant voltage source, and a drain electrode of the second FET constituting an output terminal

of the constant current circuit; and

## Brief Statement under Article 19(1)

In claims 2, 3 and 11, the objects of phase comparison are made clear by correcting the language "the phase of the rising edge of the reference signal" as "the phase of the reference signal".

Also, in claim 10, the objects of phase comparison are made clear by correcting the language "comparing the phase of the rising edge of the reference signal with the phase of the apex of the formed sawtooth wave" as "comparing the phase of the reference signal with the phase of the formed sawtooth wave".